Design and Development

(1) Overview of design and development

a. Determination and stabilization of frequency

This equipment adopts the frequency hopping method in which transmission and reception as well as frequency-channel division are carried out on a time-sharing basis.

As a result, one voltage-controlled oscillator (VCO) performs transmission and reception.

The same VCO for local oscillation is shared for reception and transmission, and the oscillation frequency is 2399-2477 MHz during reception while it is 2402-2480 MHz during transmission.

b. Modulation limitation, spurious radiation suppression, power restriction and receiver secondary radiation

For modulation limitation, the baseband signals are filtered with a Gaussian filter to perform band limitation.

Transmission spurious radiation outside the receiving band is suppressed through the use of a receiving-frequency pass filter in the latter part of the transmission/reception switching circuit (D10, D11).

Power restriction is strictly controlled by carrying out a 100% inspection during the transmission power check process during production.

For suppression of the electric waves emitting secondarily from

the receiver, the leak of the local oscillation frequency to the antenna edge is prevented by using an image interference removal mixer in a mixed circuit and the balance type for the input terminal of a high-frequency amplifier circuit and covering a high-frequency board with a shielding case thereby suppressing radiation as much as possible.

c. Usage, operating environment, part variations and secular changes

Considering the usage and operating environment for Bluetooth equipment, heat-resistant ABS resin, which is superior in impact resistance and heat resistance, is used in the enclosure.

Considering the part variations, a 100% inspection is carried out for the antenna power during the production process.

(2) Design Standard Values

Item

Design Standard

1. Deviation of transmission frequency: Within ±10 ppm

2. Occupied frequency bandwidth: 80 MHz

3. Diffusion bandwidth: 72 MHz

4. Spurious emission strength: 0.1μW or less

5. Antenna power: 0 dBm

6. Strength of electric waves emitting secondarily

1 nW or less

Operation of Each Part

(1) Reference oscillator and frequency synthesizer

The reference frequency, which is input into the transmission unit, receiving unit, modulation unit and main controller [IC1] unit, is output from a temperature compensated crystal oscillator of 13 MHz [X4]. This oscillator is temperature-compensated in such a manner so as to have a frequency stability of ±10 ppm at an ambient temperature of -10°C to +60°C, and it is used as a reference frequency for the PLL synthesizer for local oscillation frequency and as a reference clock for the main controller [IC1].

The frequency of the VCO for local oscillation within a transceiver [IC10] is 2399-2477 MHz during reception while it is 2402-2480 MHz during transmission. Combining this VCO with the PLL unit built in a transceiver [IC10] in [U1] makes up

the frequency synthesizer circuit.

(2) Transmission unit

The data signal output from the main controller [IC1] is input into the Gaussian low-pass filter in the transceiver [IC10], and the band-limited output is input into the VCO tank circuit [D13, D14] for frequency modulation.

The VCO output is amplified with a power amplifier and radiates out from the antenna [ANT1] through the balun [T11], transmission/reception switch [D11] and receiving bandpass filter [FIL10].

(3) Antenna

The antenna [ANT1] of this equipment is the ë/4 single type. The antenna, which is included in the enclosure, has a structure that does not allow users to easily replace it.

(4) Receiving unit

The receiving wave (2402-2480 MHz), after the out-of-receiving-band spurious wave being eliminated via a two-way band pass filter [D10], is input into a low noise amplifier within the transceiver [IC10] through transmission/reception switch [D10] and the balun for receiving [T10].

The receiving wave amplified with the low noise amplifier is converted into the intermediate frequency (3 MHz) through a

mixer [MIX] within the transceiver [IC10] and a band pass filter for intermediate frequency [BPF]. The local oscillator used at this time is made by the same PLL frequency synthesizer circuit as the one used in the transmission unit.

The intermediate frequency signal output from the band pass filter [BPF] is amplified with a limiter amplifier before being input into the demodulator and main controller [IC1].

(5) Main controller

The transceiver [IC10] [IC1] is equipped with a function of a link manager layer in the baseband of Bluetooth.

As interfaces, there exist a ① serial controller for PLL channel select data built in the transceiver [IC10], ② various switches and an RF control port for power control in the radio system [U1] including the transceiver [IC10], ③ input port for various reference signals, ④ port to control external memory [IC4], ⑤ port to control LED [CD3] lighting on/off and a ⑥ memory stick interface, which interfaces with the host equipment.

In addition to the above, there are RISC CPU, which is a core part, baseband controller and built-in flash memory.

The main controller [IC1] reads the program code (firmware) from the built-in flash memory when power is switched on, performs the initial setting of the baseband controller and radio system [U1] and operates according to the link manager

layer in the baseband of Bluetooth.

(6) Memory unit

The memory device is used as follows:

Type

Application

Flash Rom built-in main controller

Code area

E2 PROM [IC4]

Bluetooth address

(7) CPU processing unit

The CPU, which is built in the main controller [IC1], controls the entire hardware system with the built-in flash ROM. For the CPU clock, a clock, which operates with a ceramic radiator [X1] when power is switched on and is produced in the oscillating circuit of the transceiver [IC10] with control from the host equipment, is supplied as the external clock.

(8) Power supply unit

The main controller [IC1] controls ON/OFF of the power system [IC5] in the radio system [U1].